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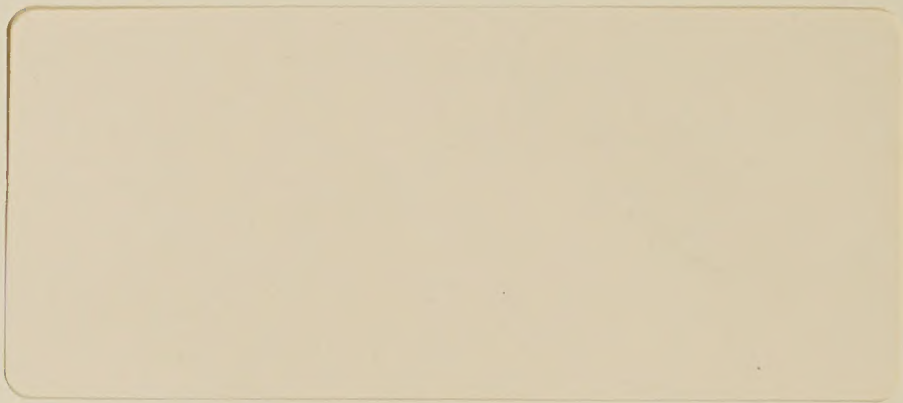
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LAND RESOURCES REPORT

# Hamakua Area Agricultural Water Study

UNITED STATES DEPARTMENT OF AGRICULTURE  
Economics, Statistics, and Cooperative Service  
Forest Service  
Soil Conservation Service

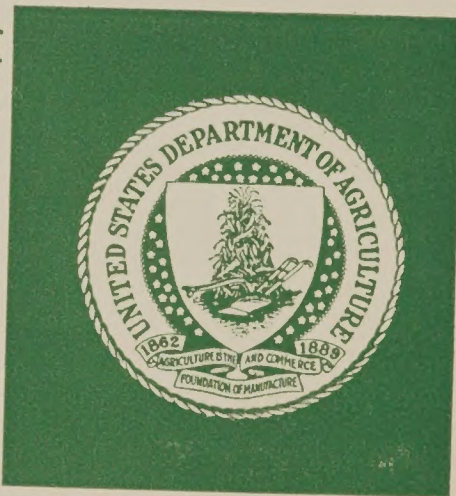
STATE OF HAWAII  
Department of Land and Natural Resources  
Mauna Kea Soil and Water Conservation District



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LAND RESOURCES REPORT

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Prepared by:

United States Department of Agriculture  
Soil Conservation Service  
Honolulu, Hawaii

November 1981



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## INTRODUCTION

### Purpose

The purpose of this report is to inventory, evaluate, and identify problems of land resources within the Hamakua Area Agricultural Water Study (HAAWS). This report discusses land ownership and use; soils; prime agricultural lands; land resource development potential for sugarcane, truck crops, orchards and pasture; and erosion and sedimentation problems.

### Description of Study Area

The study area, encompassing approximately 211,660 acres, lies in the northeastern portion of the island of Hawaii, the southernmost and largest island in the state of Hawaii. The area is bounded by Laupahoehoe to the east, the Pacific Ocean to the north, Waipio Valley to the west and the Mauna Kea Forest Reserve to the south. It includes parts of the Hamakua, North Hilo and South Kohala Districts of the County of Hawaii (Fig. 1).

The climate in the study area is most influenced by elevation. Average annual temperatures range from 75°F along the coastline to 40°F on the upper slopes of Mauna Kea. Records indicate that average temperatures decrease at an approximate rate of 1°F for every 300 feet increase in elevation up to 1,000 feet and at a lower rate of decrease at higher elevations. Temperatures at various elevations fluctuate little throughout the year.

The northeasterly trade winds contribute to the high rainfall along the Hamakua Coast. Average annual rainfall along the Hamakua Coast varies from 60 inches along the coastline to 100 inches at elevation 2,500 feet and decreases thereon up the slope of Mauna Kea. Rainfall in the Waimea area varies from 20 inches in the plains area to 175 inches annually in the Kohala Mountains. The highest rainfall occurs in the Kohala Mountains and the Ookala area with 175 inches annually.

## LAND OWNERSHIP AND USE

### Land Ownership

Like the rest of the state, most of the land in the study area is owned by a few major landowners. The state of Hawaii, Department of Hawaiian Home Lands, and the large private owners, consisting of Parker Ranch and Davies Hamakua Sugar Company, account for about 73 percent of the study area (Table 1).



TABLE 1  
LAND OWNERSHIP

Landowner	Acres	Percent
State of Hawaii	43,350	20.5
Department of Hawaiian Home Lands	32,570	15.4
Parker Ranch	46,000	21.7
Davies Hamakua Sugar Company	32,000	15.7
Other - Private	57,740	26.7
TOTAL	211,660	100.0

State-owned land is administered by the Department of Land and Natural Resources and is mainly used for forest reserve or conservation purposes.

As a result of the Hawaiian Homes Commission Act of 1920, certain public lands were set aside for "native Hawaiians" (persons possessing greater than 50 percent Hawaiian ancestry). Subsequently, in 1959, administration of these lands was turned over to the Department of Hawaiian Home Lands (DHHL) with the Commission, set up by the Act of 1920, serving as the executive board. These lands are leased to "native Hawaiians" for homesteading purposes and include residential and agricultural lots in the Nienie, Kapulena and Puukapu areas.

#### Land Use

The present land use pattern has been strongly influenced by the agricultural activities in the past. Sugar plantations with their camps, towns and mills, such as Honokaa, Paauilo, Ookala and Laupahoehoe, have established the urban and agricultural land use pattern along the Hamakua Coast while Parker Ranch and truck crop farmers have done the same for Waimea and its surrounding area.

Table 2, Major Agricultural Land Uses provides a detailed breakdown of land use within the agricultural sector. Tax key, county zoning, topographic, and area maps along with other data were used to determine the locations and acreages of the various agricultural enterprises (Fig. 2).





FIGURE 1  
**LOCATION AND LAND USE MAP**  
**HAMAKUA AREA AGRICULTURAL**  
**WATER STUDY**  
**HAWAII**

DECEMBER 1981

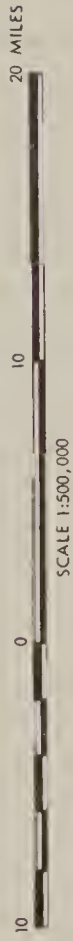




TABLE 2  
MAJOR AGRICULTURAL LAND USES

Land Use	Acres		Percentage of Study Area	
	Nonirrigated	Irrigated	Nonirrigated	Irrigated
Sugarcane	28,825	6,895	13.7	3.2
Pasture	122,620	0	57.9	0
Truck Crops	0	560	0	.3
Orchards	1,190	20	.6	0
Forest	22,740	0	10.7	0
Miscellaneous	28,810	0	13.6	0
TOTAL	204,185	7,475	96.5	3.5

Sugarcane is grown on approximately 35,720 acres by the Davies Hamakua Sugar Company and 165 independent growers. Sugarcane is grown along the coastline from elevations near sea level up to 2,600 feet (Fig. 2).

Approximately 122,620 acres are used for pasture by Parker Ranch, two dairies and about 150 smaller ranches. Parker Ranch is located on the slopes of Mauna Kea and the Kohala Mountains; while the smaller ranches and dairies are scattered throughout the study area. These ranches manage a total of about 52,000 head of livestock.

About 560 acres are presently being cultivated for the production of truck crops. The Puukapu area and the Lalamilo farmlots located in Waimea are the main truck crop farming areas. These areas have fertile soils, and with the cool climates are well suited for the production of crops, such as head cabbage, head lettuce, Chinese cabbage, romaine lettuce, celery, broccoli, and various flowers. Root crops, such as burdock, daikon, beets, and carrots, are also grown in the nonstony areas. There are a few small truck farms along the Hamakua Coast that grow warm-climate crops, such as tomatoes and cucumbers. Waipio Valley is one of the major taro producing areas in the state. See Fig. 2 for the locations of major truck crop farming areas.

Macadamia is the principal orchard crop in the study area. At present, there are about 45 farms with 1,190 acres of land in macadamia nut production. Macadamia farms are scattered throughout the study area from elevations 700 feet to 2,800 feet.

There are 22,740 acres of forest within the study area. Most of it is located above the sugarcane fields and is maintained as forest reserves (Fig. 2).

The 28,830 acres of miscellaneous land include urban and conservation areas, and also idle land. Urban areas are centered around several plantation towns located along the major highways. Waimea is the largest urban center in the area. The area in conservation is part of the Mauna Kea Forest Reserve. Idle land includes gulches and barren lava flows. These areas are relatively small in size and are not shown in Fig. 2.

#### State Land Use Districts

The state of Hawaii, in order to insure orderly development and use of land, enacted the State Land Use Law in 1961, which established four land use districts: urban, rural, agriculture, and conservation (Fig. 3). Table 3 shows the acreage in each land use district in the HAAWS area.

TABLE 3  
LAND USE DISTRICTS

Land Use District	Acres	Percentage
Urban	1,840	0.9
Rural	0	0
Agriculture	175,950	83.1
Conservation	33,870	16.0
TOTAL	211,660	100.0

Urban districts include lands presently in urban use plus sufficient reserve areas to accommodate foreseeable urban growth. The county of Hawaii regulates land use within this district.

Rural districts, created as a result of an amendment to the law in 1961, include areas composed of small farmlots with a minimum of one-half acre in size and also low density residential lots with no more than one house per half acre. Land use regulations in the rural districts are established by the State Land Use Commission and administered by the county of Hawaii. There are no rural district lands in the study area.

Agriculture districts include lands used for agricultural purposes and lands with potential for cultivation. Agricultural purposes include the growing of sugarcane, truck and orchard crops and cattle ranching. Like the rural districts, land use regulations in the agriculture districts are established by the State Land Use Commission and administered by the county of Hawaii.

Conservation districts include lands managed to protect watershed cover and water supplies, preserve scenic areas, provide for recreation areas, preserve terrestrial and aquatic natural areas including flora and fauna, prevent floods and soil erosion, and control the use of renewable and nonrenewable natural resources.

The State Department of Land and Natural Resources is responsible for the establishment and enforcement of land use regulations on state and privately owned lands in the conservation districts.

## LAND RESOURCES

### Soils

The area has a wide variety of soils as a result of extreme differences in climate, vegetation, topography and age.

Annual rainfall ranges from 20 inches below Waimea and on the high slopes of Mauna Kea to 175 inches on the wet windward slopes of the Kohala Mountains. Elevation ranges from near sea level to 7,000 feet. The average annual temperature at sea level is 75°F and decreases on the average 1° for every 300 feet in elevation. Parent materials range in age from Pliocene to recent. They are dominantly volcanic ash and basic igneous rock. Detailed information on each soil is described in the Soil Survey of the Island of Hawaii, State of Hawaii (1973).

The soils along the Hamakua Coast are derived from volcanic ash and are mostly continuously moist. They have low inherent fertility due to leaching of bases, but respond readily to fertilization. Sugarcane is the principal crop.

At higher elevations, the soils are developing in volcanic ash with a high content of bases due to limited leaching. The pH is neutral and the soils have higher inherent fertility. These soils have a moderate erosion hazard.

Below Waimea the climate is arid and vegetation is sparse. Very little leaching of bases has occurred in soils of this region and while these soils are fertile, they are very erodible. Many areas are shallow over bedrock or are very stony.

The most productive soils in this area are found around Waimea town. They have good chemical and physical properties. These volcanic ash soils are easily cultivated. Rainfall is low and crops require irrigation.

Agricultural Lands of Importance to the State of Hawaii

One purpose of the soil survey is to help identify the extent and location of lands suitable for the production of food, feed, fiber, and forage. This will aid management in making decisions that concern agricultural planning and development.

Three classes of Agricultural Lands of Importance to the State of Hawaii (ALISH) were established: prime agricultural land, unique agricultural land, and other important agricultural land. Urban and built-up lands and state lands (e.g. forest reserves) were not classified in the rating (Fig. 3).

TABLE 4

AGRICULTURAL LANDS OF IMPORTANCE TO THE STATE OF HAWAII

Classes	Acres	Percentage
Prime Agricultural Land	30,900	22.7
Unique Agricultural Land	100	< 0.1
Other Important Agricultural Land	<u>104,900</u>	<u>77.2</u>
TOTAL	135,900	100.0

"Prime agricultural land" is land that is best suited to producing food, feed, forage, and fiber crops. It has the soil qualities, growing season, and moisture supply needed to economically produce a sustained high crop yield when the land is managed properly. Prime agricultural land has the potential for highest yields with minimal inputs of energy and economic resources and is compatible with the environment.

Prime agricultural land can be land that is used for crops, pasture, forest, or other uses. It must either be used for producing food or fiber or be available for these uses.

Prime agricultural land has an adequate and dependable supply of moisture from rainfall or irrigation. In general, it also has favorable temperature, growing season, soil acidity, and does not have harmful amounts of salt or sodium. It has few or no stones and is permeable to water and air. Prime agricultural land is not excessively eroded or saturated with water for long periods and is not frequently flooded.





"Unique agricultural land" is land other than prime agricultural land that is used for specific high-value crops such as coffee, taro, rice, watercress, or pineapple. The land has the special combination of soil qualities, growing season, temperature, humidity, sunlight, elevation, aspect, moisture supply or other conditions that are necessary for the growth of these crops.

"Other important agricultural land" is land other than prime or unique agricultural lands that have statewide or local importance for the production of food, feed, fiber and forage crops. These lands are important to agriculture in Hawaii, yet exhibit properties such as seasonal wetness, erodibility, shallow depth, steep slope, flooding or stoniness that exclude them from being prime or unique agricultural lands.

### Soil Suitability Ratings

While the ALISH ratings and maps show in a general way where the best agricultural lands are, they do not show the relative suitability of soils for a given use such as those given in a soil suitability or soil potential rating.

The soil suitability ratings are based on soil properties that affect the growth of crops and ease in cultivation. The soils are rated in their natural state; that is, no unusual modification is made of the material other than that which is considered normal practice.

### Soil Suitability Ratings for Truck Crops

Soil properties important in this rating are those that affect cultivation, soil erosion, and the uptake of nutrients and water by the crops. They are slope, soil texture, stoniness, and depth.

This soil rating is for the mechanized production of climatically adapted truck crops only, and it does not apply to such crops as watercress and taro which require wetland conditions. This rating assumes that irrigation water is available for all the soils.

The soil suitability ratings are defined as follows:

A rating of good means the soils have properties favorable for machine cultivation and the growth of climatically adapted truck crops.

A rating of fair means the soil is moderately favorable for machine cultivation and the growth of climatically adapted truck crops. One or more soil properties make these soils less desirable than those rated good.

A rating of poor means the soil has one or more properties unfavorable for machine cultivation and the growth of climatically adapted truck crops. Overcoming the unfavorable property requires special farming methods, extra maintenance, or costly modification of the soil or site.

A rating of very poor means the soil is unsuited for the use, or extreme measures are needed to overcome the undesirable soil properties.

The soil suitability ratings for truck crops and acreages in the study area are shown in Table 5.

TABLE 5  
SOIL SUITABILITY RATINGS FOR TRUCK CROPS

Rating	Acres
Good	13,810
Fair	111,290
Poor	47,880
Very Poor	<u>38,680</u>
TOTAL	211,660

Soil Suitability Ratings for Macadamia Nuts

Macadamia nuts are usually grown below the 3,000-foot elevation. The higher elevations are considered too cold for the production of macadamia nuts.

The properties considered in rating the soil suitability for macadamia nuts are slope, depth to bedrock, soil temperatures, sunlight, elevation, and moisture supply.

The soil suitability ratings for macadamia nuts are as follows:

A rating of good means the soil qualities, temperature, sunlight, and moisture supply are favorable for the production of macadamia nuts.

A rating of fair means the soil qualities, temperature, sunlight, and moisture supply are moderately favorable for macadamia nut production. One or more of the properties make the soil less desirable.

A rating of poor means there are one or more properties unfavorable for the production of macadamia nuts. Overcoming the unfavorable property requires costly modification of the soil.

A rating of very poor means the soil is unsuited for the production of macadamia nuts, or extreme measures are needed to overcome the undesirable soil properties. One example is that the soil temperature is too cold for macadamia nut production.

Table 6 shows the soils ratings and acreages in the study area when used for the production of macadamia nuts.

TABLE 6  
SOIL SUITABILITY RATINGS FOR MACADAMIA NUTS

Rating	Acres
Good	18,070
Fair	30,570
Poor	60,020
Very Poor	<u>103,000</u>
TOTAL	211,660

Soil Potential Ratings for Sugarcane

Soil potential ratings indicate the relative quality of a soil for the production of sugarcane as compared with other soils in the area. Each soil mapping unit was evaluated to determine the crop yield, the corrective measures needed to overcome soil limitations or continuing soil limitations, and their relative cost to produce these crop yields. This evaluation results in a relative potential rating of four classes. The class terms and definitions are as follows:

High. Production or performance is at or above the level of local standards; costs of measures for overcoming soil limitations are judged locally to be favorable in relation to the expected performance or yields; and soil limitations continuing after corrective measures are installed do not detract appreciably from environmental quality or economic returns.

Medium. Production or performance is somewhat below local standards; or costs of measures for overcoming soil limitations are high; or soil limitations continuing after corrective measures are installed detract from environmental quality or economic returns.

Table 7 shows the soils rating and acreage in the study area when used for sugarcane.

TABLE 7  
SOIL POTENTIAL RATINGS FOR SUGARCANE

Rating	Acres
High	22,270
Medium	28,970
Low	770
Very Low	<u>159,650</u>
TOTAL	211,660

Pasture Productivity Ratings

Most of the soils in the study area are suitable for growing adapted grasses and legumes. The principal difference is the kind and amount of forage that can be produced. The productivity ratings (in pounds)--very poor (<1,000), poor (1,000-3,000), fair (3,000-7,000), and good (>7,000)--are based on the amount an improved pasture produces; expressed in air-dry forage per acre annually. These figures are derived from the pasture section of the Soil Survey of the Island of Hawaii.

The acreage of soils with the various forage production potential are given in Table 8.

TABLE 8  
PASTURE PRODUCTIVITY RATINGS

Rating	Acres
Good	106,380
Fair	27,230
Poor	39,380
Very Poor	<u>38,670</u>
TOTAL	211,660

### Land Resource Development Potential

At the present time, the State of Hawaii is dependent on imports for much of its supply of fresh vegetables and beef. In 1979, 40 percent of the fresh vegetables and 32 percent of the beef consumed in Hawaii were produced locally. With the rapidly increasing cost of transporting produce overseas, Hawaii's ranchers and farmers are better able to compete with the large scale operations on the mainland. Hawaii's farmers can also take advantage of year-round growing conditions by supplying winter vegetables to the mainland.

The production of sugarcane has been the most important agricultural industry in Hawaii since the early 1900's. Fluctuating sugar prices and increasing production costs have made the growing of sugarcane a risky venture, especially for the smaller independent growers. The sugar industry is continually looking for ways to cut costs and increase production and efficiency.

The State of Hawaii has been looking at diversified agriculture as a means of stabilizing its agriculture sector and increasing exports. The production of orchard crops, such as macadamia nuts and guava has increased rapidly over the past several years. The market for these crops looks promising and there is potential for continued expansion of these crops.

The following sections analyze the potential of increasing the production of sugarcane, truck crops, orchard crops, and livestock in the study area. Production can be increased by developing more land for a particular use and or by utilizing the present land to its fullest potential. The potential of developing more land for a particular use is analyzed in terms of soil and climate suitability, present land use patterns, future land use plans, land ownership, and the availability of water resources. The land presently in a particular use can be made more productive by applying irrigation or by following better or more intensive management practices.

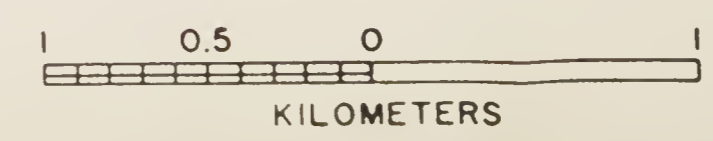
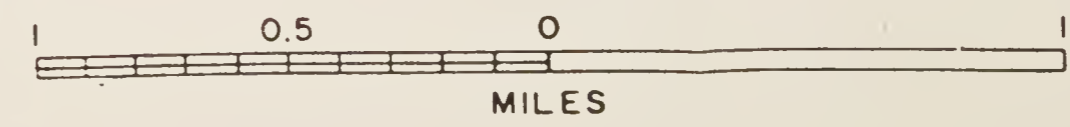
#### Potential for Sugarcane

Of the 92,600 acres of sugarcane grown on the island of Hawaii, 35,720 acres are within the study area. The Davies Hamakua Sugar Company operates 32,000 acres and 3,720 acres are operated by 165 independent growers. Little additional lands can be brought into sugarcane production. The areas not presently in sugarcane are unsuitable because of cold temperatures, steep slopes or shallow and stony soils. However, there is a potential for increasing sugarcane production on the present acreages. Yields per acre can be increased by converting to more efficient methods of irrigation or irrigating previously unirrigated fields.





SCALE



LEGEND

- Non Irrigated (Potential Irrigation)
- Planned Drip Irrigation
- Planned Overhead Irrigation

Planned And Potential Areas  
For Sugarcane Irrigation

Homakua Area Agricultural Water Study

Figure 4a











At the present time, 6,895 acres of sugarcane are irrigated. All of these acreages are operated by Davies and are located below the Lower Hamakua Ditch (LHD). Of the 6,895 acres, 1,854 acres are drip and 5,041 acres are overhead irrigated. Davies has developed an irrigation conversion plan through the year 1987. The plan involves converting 4,269 acres from overhead to drip, 727 acres from nonirrigated to drip, and 337 acres from nonirrigated to overhead irrigation. In 1987, there will be a total of 7,959 irrigated acres, 6,329 acres will be in drip, and 1,630 acres will be in overhead irrigation (Fig. 4 and Table 9).

TABLE 9

PRESENT AND PLANNED AREAS FOR SUGARCANE IRRIGATION

	Present Acreage				Planned Acreage (1987)			
	Irrigated <sup>1/</sup> Drip	Non- Overhead irrigated		Total	Irrigated <sup>1/</sup> Drip	Non- Overhead irrigated		Total
Davies								
Hamakua	1,854	5,041	25,105	32,000	6,329	1,630	24,041	32,000
Inde- pendent Growers	0	0	3,720	3,720	0	0	3,720	3,720
TOTAL	1,854	5,041	28,825	35,720	6,329	1,630	27,761	35,720

<sup>1/</sup> Below the Lower Hamakua Ditch.

The Davies irrigation system is limited by the amount of water that is available in the LHD during periods of low rainfall and the lack of adequate storage reservoirs. Davies presently has a water deficit of 7.5 MGD. The planned conversion from sprinkler to the more efficient drip systems will lower the overall water requirements of the company. However, Davies will still have a water deficit after the conversion is made.

The 27,761 acres not included in Davies irrigation plans could benefit from some type of irrigation. Davies has indicated that the 20 inches per year iso-line, representing the annual irrigation requirement of sugarcane, is the boundary below which intensive irrigation is required (Fig. 4). Areas above this line would require only supplemental irrigation. There are 6,107 acres below and 21,654 acres above the 20 inches per year iso-line.

The 6,107 acres of nonirrigated sugarcane below the 20 inches per year iso-line would benefit from either intensive sprinkler or drip irrigation. Of the 6,107 acres, 2,913 are below the LHD and 3,194 are above the LHD. For the area below the LHD, Davies estimates an increase in yields of 4 tons of sugar (TSA) if drip and 3 TSA if sprinkler irrigated. For the area above the LHD, yields are estimated to increase 3 TSA if drip and 1.5 TSA if sprinkler irrigated.

The 21,654 acres above the 20 inches per year iso-line would benefit from supplemental irrigation. Portable overhead irrigation systems could be used to supply water to these areas during periods of low rainfall. Supplemental irrigation for these areas would not substantially increase yields, however normal yields could be maintained.

#### Potential for Truck Crops

A total of about 1,370 acres in the study area has been developed for truck crop farming. At the present time, about 560 of these acres are cultivated.<sup>1/</sup> The main truck farming areas are the Lalamilo and the Puukapu-Hawaiian Homes farmlots in Waimea. There are also a few small farms located in the Ahualoa, Honokaa, and Kalopa areas along the Hamakua coastline.

The potential of increasing the production of truck crops was analyzed in terms of cultivating more of the already developed areas and developing additional acres.

The 560 acres presently under cultivation are intensively farmed at a high level of management. Yields per crop acre are some of the highest in the state. Yields cannot be significantly increased unless technology makes it possible through the development of new cultivars, chemicals, or production methods.

However, total production can be increased if more acres in the presently developed areas were cultivated. Many areas are idle or are used for pasture. Although the number of acres cultivated has been increasing steadily over the years, continued growth may be limited by the amount of water available for irrigation.

The present Lalamilo farmlots area is serviced by the state agricultural water system. Farmers in the Puukapu-Hawaiian Homes area use domestic water from the County of Hawaii system. They are looking for a source of agricultural water to replace their domestic supply.

---

<sup>1/</sup> Represents average number of acres of irrigated truck crops in the ground during any given period.

Waimea is one of the fastest growing areas in the state. The growing population will increase the competition for the already limited supply of domestic water. There is a possibility that domestic water for agricultural uses will be restricted or cut off in the future.

During a recent drought, farmers on both the agricultural and domestic systems were put on a restricted irrigation schedule. Yields dropped by as much as 25 percent and many farmers had to delay planting new crops.

Waimea is considered to have the most potential as an area for developing additional acres for truck crop production. The soils and climate in the area are well suited for truck crops. There is a commitment on the part of the state to promote and support agriculture in Hawaii. As mentioned earlier, the state has plans to develop an agricultural park in the Lalamilo area and to also improve their present agricultural water system. The Department of Hawaiian Home Lands, a major landowner in Waimea, also has plans to open up additional homestead areas for farming.

The Soil Conservation Service did an intensive soil survey of 19,550 acres in the Waimea area. The soil suitability ratings for truck crops, developed from the survey, show the relative suitability of the soils for truck crop production. The soils surveyed were given a rating of "good", "fair", "poor", or "very poor" (Fig. 5). These ratings were defined in an earlier section on page 10.

TABLE 10  
SOIL SUITABILITY RATINGS FOR TRUCK CROPS  
IN THE WAIMEA AREA

Rating	(1) Total Area	(2) Present Truck Crops Area	(3) Present Urban Area	(4) Planned Truck Crops Area	(5) (5 = 1-2-3-4) Potential Area
	----- (Acres) -----				
Good	8,090	1,200	650	185	6,055
Fair	3,710	30	5	210	3,465
Poor	5,170	140	5	450	4,575
Very Poor	<u>2,580</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2,580</u>
TOTAL	19,550	1,370	660	845	16,675



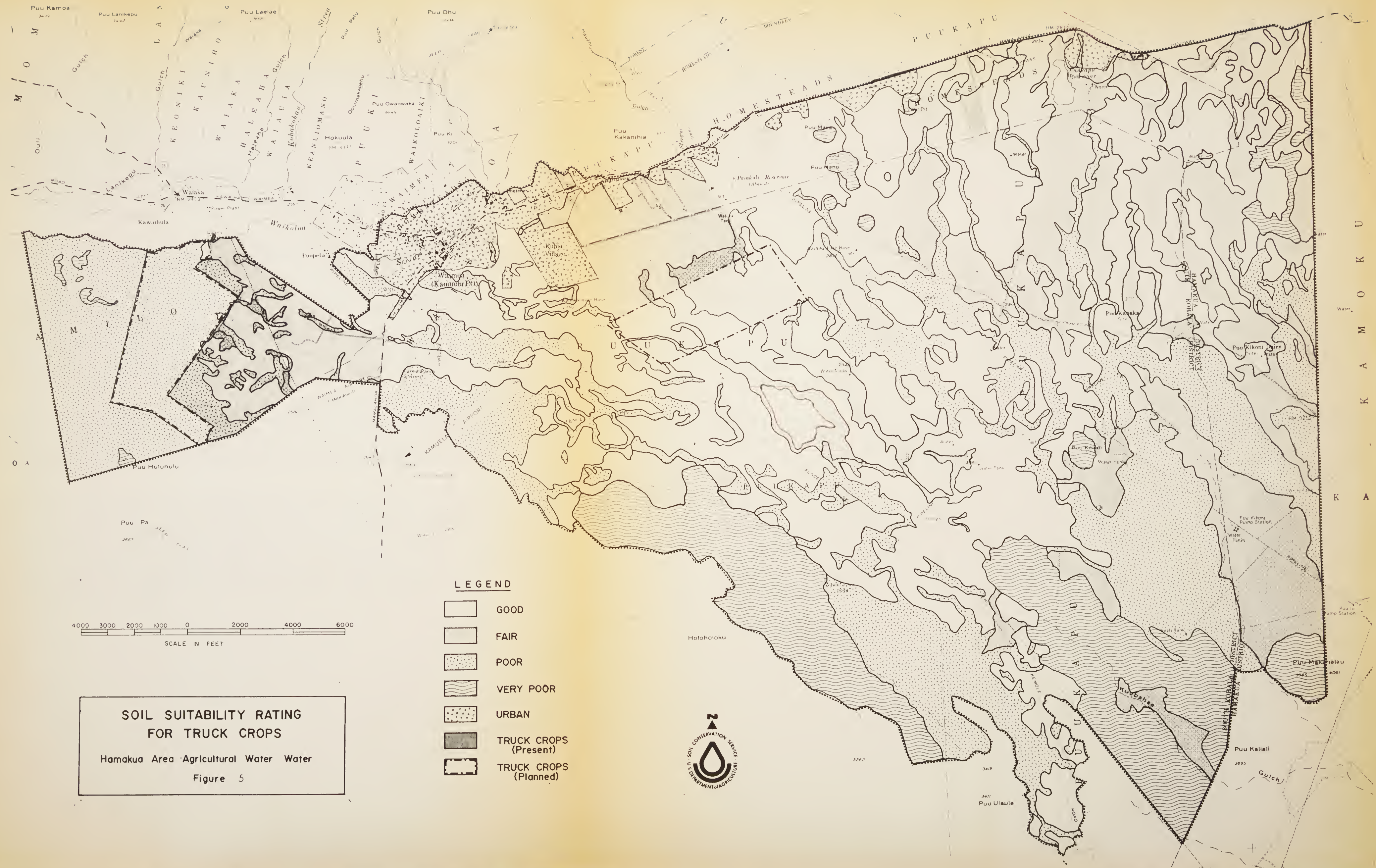


TABLE 11  
AVERAGE YIELDS FOR TRUCK CROPS  
IN LALAMILO AND PUUKAPU<sup>1/</sup>

Crop	Yield <sup>2/</sup> (Lbs./Acre)
Beets	27,000
Broccoli	12,800
Burdock	13,200
Cabbage, Chinese	29,000
Cabbage, Head	30,000
Carrots	12,000
Celery	55,000
Daikon	11,250
Lettuce, Head	16,000
Onions, Dry	15,000
Parsley	12,600
Romaine	19,600

<sup>1/</sup> Hawaii Technical Guide,  
Section V-C.

<sup>2/</sup> Irrigated.

#### Potential for Orchards

Macadamia nuts are the principal orchard crop grown in the study area. There are 45 macadamia nut farms in the area with a total of 1,190 acres. The farms are scattered throughout the area, both within and above sugarcane fields.

Macadamia nuts can be grown in the same soils and climatic region as sugarcane. Thus, all land currently in sugarcane could be considered potential areas for expansion, if sugarcane production is curtailed.

At the present time, only 20 acres of the total 1,190 acres of macadamia nuts are irrigated. Production on the nonirrigated acres with rainfall of less than 80 inches per year could be increased if irrigation water was applied. In the higher rainfall zones, supplemental irrigation, during periods of drought, would help stabilize yields.

### Potential for Pasture

Approximately 122,620 acres of land along the Hamakua Coast and in the Waimea area are presently being grazed. Smaller pastures along the coast are located in such areas as Kukaiau, Laupahoehoe, Ahualoa, and Kalopa; while Parker Ranch's pastures are in the Waimea area and on the slopes of Mauna Kea and the Kohala Mountains. The climate in these areas varies widely with annual rainfall ranging from 20 inches to 100 inches and elevations from sea level to 7,000 feet. As a result, a wide range of grasses and legumes are grown. Stocking rates vary widely, ranging from about 15 acres per animal unit in the drier areas to one acre per animal unit in the higher rainfall zones.

Except for the very steep gulches and some lava flows, the entire study area could potentially be used for pasture. Lands in crops such as sugarcane, orchards, or truck crops are well suited for pasture; however, until it becomes uneconomical to produce these crops, these lands would be unavailable as potential pasture.

Production on the present pasture lands could be increased by improving the distribution and supply of stockwater. Many ranchers must now purchase domestic water at 45 to 55 cents per 1,000 gallons. Added to this is the high cost of pumping or hauling the water up to storage reservoirs. Some ranchers are unable to pump or haul water to some pastures because of the high cost or the limited accessibility of the area. Ranchers must rely on catchment-storage facilities for stockwater in many areas. These catchment systems run dry during low rainfall periods and cattle must be moved to areas with available stockwater.

If water could be brought up to a distribution point at a higher elevation than at present, ranchers would benefit greatly. Some of the costs of supplying stockwater could be reduced and distribution could be improved. The proper distribution and supply of stockwater to all areas would allow ranchers to increase their herd size because pastures could be efficiently grazed.

### LAND AND RELATED WATER RESOURCE PROBLEMS

Major land and related water resource problems in the study area include erosion and sedimentation. Erosion is primarily caused by erosive rainfall and/or wind on inadequately protected cropland which results in damage to roads and fields. Sediment carried in runoff from these eroding lands cause agricultural damage and water quality problems.

Land is considered to be adequately protected from erosion when conservation treatment reduces soil erosion to a point where the amount of soil eroded is equal to or less than the rate of formation of that soil.

The present situation and the future condition in the year 2000 regarding land use and the areas adequately protected is shown in Table 12. The following sections will describe the land and related water resource problems in the crop (truck crops and sugarcane) and pasture lands of the study area. Possible land treatment measures to solve these problems will also be mentioned.

TABLE 12  
STATUS OF AGRICULTURAL LANDS

	Total Acres		Land Adequately Protected	
	Present	2000	Present	2000
Truck Crops	560	600	360	480
Sugarcane				
Dryland	28,825	26,925	5,800	11,200
Irrigated	6,895	8,795	2,000	6,000
Total	35,720	35,720	7,800	17,200
Pastureland				
Zone 1 <sup>1/</sup>	34,000	34,000	17,900	29,000
Zone 2 <sup>1/</sup>	38,000	38,000	30,400	36,000
Zone 3 <sup>1/</sup>	50,620	50,620	40,500	48,000
Total	122,620	122,620	88,800	113,000

<sup>1/</sup> See Table 13

### Truck Crops

In general, truck crop lands do not have significant water erosion problems. This is due primarily to the small field sizes, gentle slopes, and the low annual rainfall typical in the truck farming areas. These lands do have a problem with wind erosion. Land preparation techniques such as disk harrowing, plowing, and leveling destroy soil structure and remove vegetative cover, thereby increasing soil susceptibility to erosion by wind and rain.

Soil erosion can adversely affect soil fertility and waterholding capacity; and thus, crop yields. Wind can also cause high evaporation losses during irrigation.

Land treatment measures to alleviate erosion problems include: conservation cropping systems, conservation tillage, crop residue use, contour farming, cover and green manure crops, grassed waterways, field windbreaks, and terrace systems.

### Sugarcane

At present, about 80 percent of sugarcane land has erosion rates that exceed soil loss tolerance values which are defined as the maximum erosion rate that will allow continued agricultural production. While some of this erosion occurs in the form of sheet and rill erosion, the larger amount is a result of gully erosion from concentrated flows. The sugarcane land is highly vulnerable to erosion during the period from harvest to the time the cane plant produces a full canopy, which is approximately a 5-month period of each 24-month growth cycle. Soil loss is estimated at 7.0 to 13.5 tons per acre per year or 0.05 to 0.10 inches/year.

In these exposed sugarcane fields, soil being moved downslope results in erosion. This soil movement can adversely affect soil fertility, structure and water-holding capacity. Erosion can damage in-field roads used to transport cane. Gullies are formed on seriously eroding roads and they must be smoothed over so cane trucks can pass. Runoff from the unprotected fields also deposits sediment on roads and in roadside ditches. Much of this sediment is carried down waterways and into the ocean resulting in pollution of the waters and sediment damage to marine life.

Land treatment measures to alleviate erosion and sedimentation include: conservation cropping systems, crop residue use, proper field road design and maintenance, cross slope farming, critical area planting, alternate block harvest, diversions, terrace systems and grassed waterways.

### Pasture

The pasture in the study area can be divided into three distinct pasture management and forage production zones.

TABLE 13

PASTURE MANAGEMENT AND FORAGE PRODUCTION ZONES		
Zone	Annual Rainfall (inches)	Elevation (feet)
1	20-40	2,000-2,500
2	40-60	2,500-4,000
3	60+	4,000+

Annual rainfall and elevation are the primary determining factors in establishing these zones.

Erosion problems are most apparent in the lower rainfall areas because these areas have sparser vegetation. Improper grazing of pastures can also cause erosion problems in any of the zones.

Land treatment measures and practices that could be used to help alleviate erosion problems in pasture areas include: pasture management, proper grazing use, fencing, planned grazing systems, and stockwater facilities.

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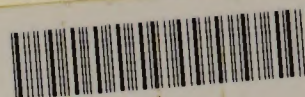
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